VEGETABLES FOR THE HOT, HUMID TROPICS

Part 4. Sponge and Bottle Gourds, *Luffa* and *Lagenaria*

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Part 1. The Winged Bean.
Part 2. Okra.
Part 3. Chaya.

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PREFACE

In the hot, humid Tropics, torrential rains during the monsoon season create special hazards for agriculture. Lands are muddied or flooded, entrance to plantings is restricted, weeds grow vigorously, chemicals applied are washed from the plants, and fertilizer is leached from the soil. High water tables drive oxygen from the soil, diseases thrive above and within the soil, and many plants are uneconomical to cultivate. These conditions make food production difficult, and agricultural skills imperative.

During tropical rainy seasons, the problem of producing highly nourishing food still exists. For the most part, the solution is to select appropriate species and varieties and know how to grow and utilize them in both conventional and unconventional ways.

Tropical diets are often unbalanced not only because of ignorance of sound dietary principles and because of food prejudices, but also because of a lack of good species and varieties. The Tropics are exceedingly varied in this respect, but knowledge is inadequate almost everywhere. Furthermore, even when appropriate varieties are known, it is often difficult to obtain seeds.

The purpose of this series of bulletins is to furnish information about vegetables that can be grown in the hot, humid Tropics. The vegetables covered are either not well known, at least with respect to some uses, or not well distributed, but are productive during tropical rainy seasons. The techniques recommended can be applied on a small scale or with a low level of technology. Seed sources are suggested when necessary.

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By Franklin W. Martin[1]

INTRODUCTION

As a group, the cucurbitaceous vegetables are best suited to dry regions, because they are susceptible to a wide variety of diseases encouraged by humidity and heavy rainfall. The popular summer squashes usually have a short lifetime in the Tropics, and many varieties of winter squash fail during the rainy season. A few cucurbits are capable of withstanding tropical rains but differ in resistance: *Luffa*, *Lagenaria*, *Momordica*, *Benincasa*, and *Trichosanthes* species. Each has its special characteristics and problems. None, with the possible exception of *Trichosanthes dioica* Roxb., has an outstanding nutritive value, but all are useful for the variation that they add to the diet. Furthermore, each one is a popular and much used vegetable, but in distinct and limited areas of the Tropics.

Luffa and *Lagenaria* species are not closely related botanically, but they are included together in this bulletin because they are similar in form, culture, and uses. They are easy to grow, and as a group they can provide food during the entire year under almost all tropical climatic conditions. Furthermore, they seem to have some unexplored potentials and some negative features that must be understood. They are vegetables that are pleasant to eat and readily accepted by most people, but they are underutilized.

Information in this publication was obtained from 2 years of study of

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collections of *Luffa* and *Lagenaria* in the hot, humid climate of Mayagüez, P.R., as well as from published literature.

BOTANY

Taxonomy and Nomenclature

The bottle gourd, *Lagenaria siceraria* (Mol.) Standl., is apparently the only species of its genus. The name is synonymous with *L. vulgaris* Ser. and *L. leucantha* (Duch.) Rusby. It is also called the trumpet gourd, the calabash gourd, and the white-flowered gourd. The name "bottle gourd" is especially appropriate, because this plant species is one of the few from which useful and lasting containers can be made.

Of the genus *Luffa*, two species are commonly cultivated. *L. acutangula* (L.) Roxb. is widely known as the angled loofah. *L. cylindrica* (L.) Roem (*L. aegyptiaca* Muell.) is known as the smooth loofah, the sponge gourd, or the dishrag gourd. There are at least two uncultivated species in the genus, *L. echinata* and *L. graveolens* (*4*).[2]

Origin and Distribution

The bottle gourd probably originated in Africa (*14*) and from there was widely distributed in pre-Columbian times. It traveled to India, where it has evolved into numerous local varieties, and from India to China and to Indonesia and as far as New Zealand. Archeological remains show that the bottle gourd was used in Egypt about 3500 to 3300 B.C. First records in China are of the 1st century A.D. and in New Zealand by the 12th century A.D.

Lagenaria also traveled to the New World. The dried gourds have been shown to survive in seawater for at least 224 days, and seeds have remained viable (*19*). The fruits might have traveled to the New World by sea. Remains found in Mexico date from 7000 to 5500 B.C. and in Peru from about 10000 B.C. (*14*). The bottle gourd is thus an ancient crop, widespread and well used, from warm parts of the Temperate Zone throughout the dry and wet Tropics. It is the only crop known to have been cultivated in pre-Columbian times in both the Old World and the New World. Evidence from Heiser's study (*6*) of the penis gourd in New Guinea supports the idea of cultural diffusion across the Pacific. The gourds of New Guinea are more like those of South America than those of Africa.

Luffa species originated in India. Wild forms of *L. acutangula* are still found in northwest India. *L. cylindrica* is sometimes said to have originated from *L. acutangula*, but the two species differ so much in

[2]Italic numbers in parentheses refer to items in "Literature Cited" at the end of this publication.

FIGURE 1.—Large bottle gourd of the vegetable type.

morphology and in time of flowering that such an origin does not seem likely. Furthermore, *L. cylindrica* is more widespread than *L. acutangula* and tends to go wild in many parts of the Tropics. It has evolved into many forms, and the best varieties for fiber (sponges) are now found in Japan. Both species have been introduced to all parts of the Tropics.

Description

The bottle gourd is a vigorous, annual, running or climbing vine with large leaves and a lush appearance (fig. 1). It is fast growing and may begin to flower only 2 months after seeding. The thick stem is furrowed longitudinally. The vine is much branched and climbs by means of branched tendrils arising from the stem with the leaf. The foliage is covered with soft hairs and has a musky or foul smell when crushed. The leaves of the bottle gourd are up to 40 centimeters broad, circular in overall shape, with a cordate base and smooth margins, or with a few broad lobes, or with undulate margins. Leaves have a velvety texture because of fine hairs, especially on the undersurface.

The bottle gourd is monoecious. Flowers are borne singly on the axils of the leaves, the males on long peduncles and the females on

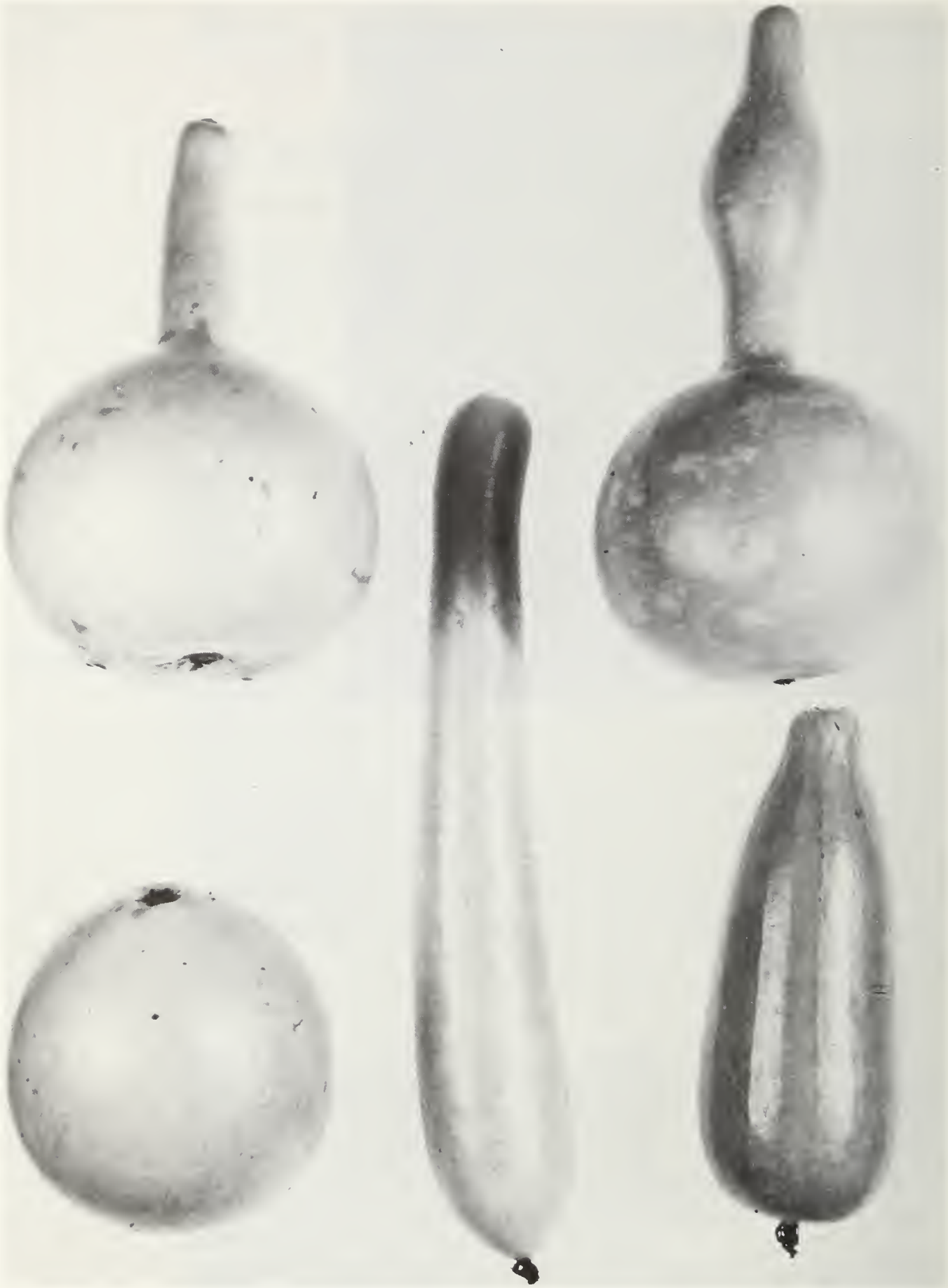

FIGURE 2.—Typical bottle gourds.

FIGURE 3.—Decorative, useful bottle gourd.

short peduncles. The flowers are white and attractive, up to 12 centimeters in diameter, with spreading petals. The ovary is inferior and in the shape of the future fruit. Otherwise, the male and female flowers are similar in appearance. The anthers are borne on short filaments grouped at the center of the flower. The stigmas are short, thickened, and branched.

The fruits of the bottle gourd show an immense amount of variation

FIGURE 4.—Vines, flower, and fruit of the smooth loofah.

in shape (fig. 2), ranging from flattened or discoidal forms to bottlelike forms (fig. 3) with one to three swollen regions, to long club shapes, sometimes over 1 meter. Furthermore, the natural forms are further varied by artificially restricting growth with bands in order to develop special forms. The brownish seeds are numerous in a whitish-green pulp.

The smooth loofah is a vigorous, annual, climbing vine with medium-size leaves and a cucumber-vine appearance, and it has a fetid odor when the foliage is crushed (fig. 4). The stem is five-angled or almost smooth, with a fine, sparse pubescence. The leaves are more or less ovate in overall shape, or at times broadly kidney shaped, cordate at the base, and acute or acuminate at the tip. They are characterized by three to seven angles or lobes, and the surface is slightly rough.

The species is monoecious, and flowers open during the day. The male flowers are bright yellow, up to 10 centimeters in diameter, rotate, with short stamens and large, clustered anthers. The flowers occur in axillary racemes, sometimes grouped in a tight cluster, of which one or two flowers open daily (fig. 5). The female flowers are usually solitary, arising on the axil, or sometimes a female flower will develop at the tip of a male inflorescence. The ovary is inferior, 2 to 10 centimeters long, smooth, and glabrous. The fruits are similar in shape to a cucumber but usually much larger (fig. 6), green and

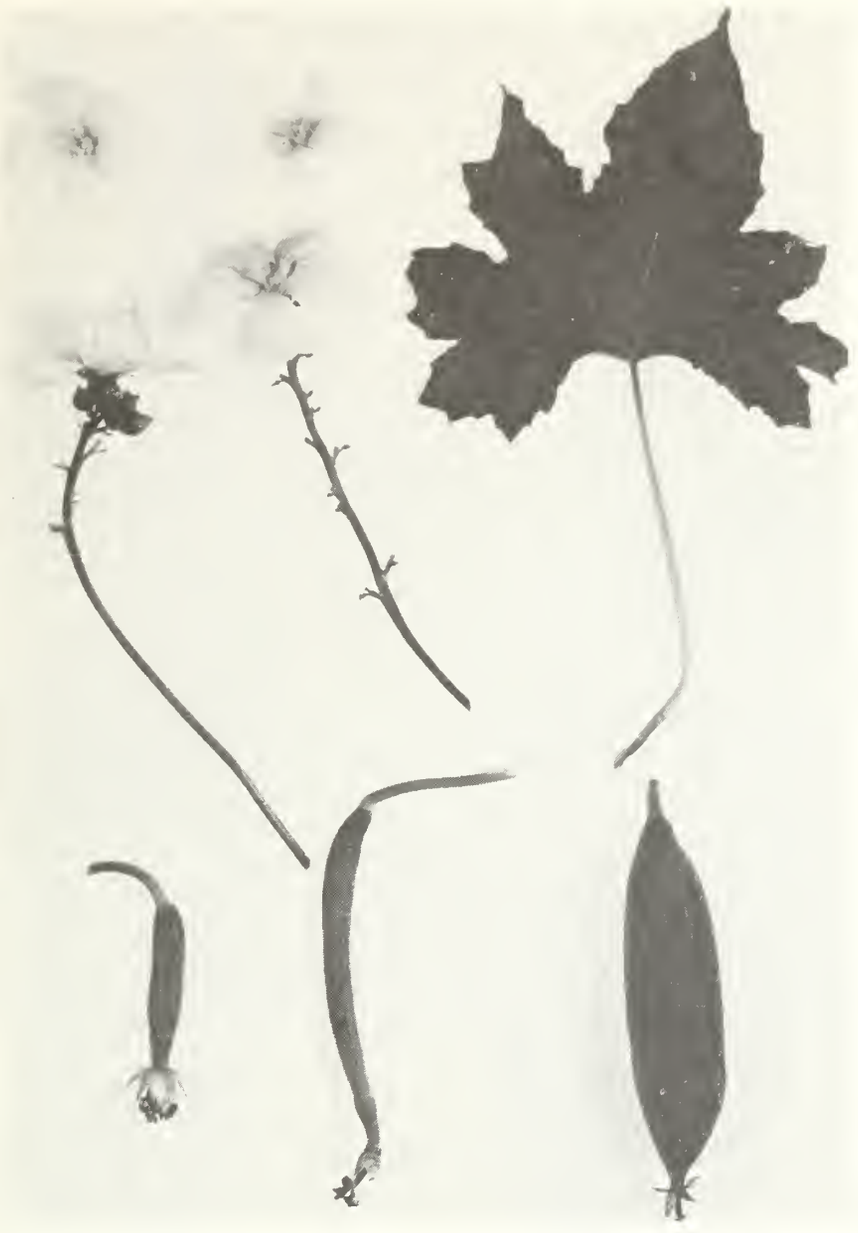

FIGURE 5.—Male flowers, leaf, and young fruits of the smooth loofah.

sometimes mottled, smooth but with longitudinal lines. The mature fruit has a network of fibers inside and a large number of flat seeds a little more than 1 centimeter long and less than 1 centimeter wide. These have a fine wing and are smooth and black or whitish.

The angled loofah is similar in appearance to the smooth loofah but is readily distinguished in that its flowers open in the late afternoon and stay open through the night (fig. 7). The stems are slender and hairy, as is the foliage in general. The leaves are ovate in general outline or cordate with acuminate tip, or even with a tail. The surfaces of the leaves are covered with short, stiff hairs. The species is monoecious, although hermaphroditic varieties are known. Male flowers are similar to those of the preceding species but smaller, up to 8 centimeters in diameter, and pale yellow. The female flowers rise from the stem between two male inflorescences. The hermaphroditic variety bears clusters of flowers, each of which can produce a small fruit. The ovary is inferior, spindle shaped, and densely pubescent, and it has 10 longitudinal ribs. The fruits are cylindrical to club shaped

FIGURE 6.—Smooth loofah fruit (left) and angled loofah fruit (right).

and can reach 70 centimeters in length and 12 centimeters in width (fig. 6). They are strongly ribbed, green, and slightly scabrous to the touch. The seeds are slightly longer and slightly narrower than those of *L. cylindrica* and are black with a pitted appearance.

Biology of Reproduction

As with most cucurbits, the sexual systems of the bottle gourds and the loofahs have attracted much study. In the bottle gourd, a number of male flowers are produced before the first female flower appears. More female flowers are produced in winter than in summer, and more by young plants than by old plants. Sprays of growth-regulating substances, including maleic hydrazide, 2,4,5-triiodobenzoic acid (50 milligrams per liter), boron at 3 milligrams per liter, and calcium at

FIGURE 7.—Vine and fruits of the angled loofah.

20 milligrams per liter, increase female flower production, fruit set, and eventual fruit size (2).

The flowers, opening in the late afternoon, are pollinated by diurnal and nocturnal insects. In India, the most important of these are *Carpophilus dimidiatus*, the corn sap beetle; *Planidia interpumetella* and *Pygaronia* spp., moths; and *Apis florea*, a small bee. Pollen is abundant and usually fertile. The stigmas are receptive to pollen germination from 6 hours before to 36 hours after anthesis (*16*). Fruit size has been related to the vigor of the plant, the number of fruits previously set, and the time of year. This relationship seems to be no more than the competition of fruits for available nutrients. Large fruits are obtained by pruning away newly set young fruits.

Among the loofahs, the sexual system is much more complex. In addition to the common monoecious condition, the variety 'Saputri' produces only hermaphroditic flowers, and dioecious varieties are found. Most study has been given to the common, monoecious type.

As with *Lagenaria*, *Luffa* spp. produce principally male flowers at first. Once female flowers appear, a ratio of about 25 male flowers to 1 female flower is established in *L. cylindrica*, and 43 to 1 in *L. acutangula* (*8*). This ratio can be changed by chemical treatments. Indoleacetic acid doubles the percentage of female flowers (*8*), whereas

morphactin and gibberellic acid increase vegetative growth and the percentage of male flowers (*10, 11*).

The stigmas of *Luffa acutangula* are receptive to pollinization from 2 hours before to 36 hours after anthesis, and the stigmas of *L. cylindrica* from 4 hours before to 60 hours after anthesis (*9*).

Luffas are cross-pollinated by a wide number of insect species, including *Anthophora* spp., *Apis florea, Ceratina voridissima, Crocisa histerio, Eristalis transpositus, Megachile monticola,* and *Xylocopa* spp. (*15*).

Cytology and Genetics

Lagenaria is a diploid with 22 chromosomes. All forms interbreed freely, and breeding is simple. Cross-pollination is done by bagging female and male buds during the afternoon and making cross-pollinations during the evening or early the next morning. The bag should be replaced on the female flower for 2 more days.

The 4 *Luffa* species are diploids with 26 chromosomes. Their interspecific crossing relationships have been studied extensively by Dutt and Roy (*4*). Chromosome pairing data were used to determine the degree of relationship between the species, and the phylogenetic relationships were established. *L. graveolens,* a monoecious species, seems to be the ancestor of the other species. *L. echinata,* a dioecious species, arose directly from *L. graveolens.* In a separate evolutionary path, *L. cylindrica* evolved, and from it the monoecious form of *L. acutangula.* From the latter developed the hermaphroditic form, sometimes called *L. hermaphrodita.* The fairly fertile crosses among the species suggest the ease of interbreeding these species to obtain desirable combinations of characters.

Little controlled breeding has been done with either the bottle gourds or the sponge gourds. Because these species are open-pollinated, varieties are always heterozygous, and variation occurs in every seed lot. By careful crosses, selection, and isolation it should be possible to develop new and uniform varieties. On the other hand, because bottle gourds are grown chiefly as backyard crops, varietal identity is readily lost.

VARIETIES

Variation

The bottle gourd has shown great variation in Puerto Rico with respect to all of the characters influencing its use as a vegetable for the hot, humid Tropics, and for its use as a container. Introduced varieties from a collection of 70 accessions differed in vigor from the moment of germination, and types were found completely unadapted to local

conditions. Adapted varieties were vigorous and rapidly climbed to the top of bamboo supports, producing large quantities of foliage and many flowers. Varieties differed in earliness of flowering and fruit set by a month or more. The earliest varieties fruited and foliage died while the latest were only starting.

Diseases are common in *Lagenaria*, and varieties differ in resistance. Powdery mildew is the most important disease during dry weather, and anthracnose is important during the rainy season. Fruits are affected by a fungal disease, especially during the rainy season. Virus disease is seen in some cases. Walking through a field of bottle gourds, one is impressed with the wide variation in incidence of these diseases. However, caution must be exercised in evaluating resistances. Early-maturing varieties tend to show disease symptoms earlier than late-maturing varieties, and dieback of foliage can result from disease or physiological maturity.

The most spectacular variation in bottle gourds is with respect to the fruits. The background color is either light green or dark green. Dark green color can be distributed as a solid color, as regular or irregular stripes, and as an irregular blotch. The size of the fruit varies from 5 to 35 centimeters in diameter and from 10 to 120 centimeters in length. The shape of the fruit is variable. The fruit can have a sterile (seedless) neck, which varies from a few to 40 centimeters in length and 2 to 4 centimeters in width. Wider necks usually contain seeds, and the neck may have a seed-containing bulge. The seed-containing portion of the fruit varies from discoidal to globose, to ellipsoidal, cylindrical, club shaped, or long and narrow. The long, narrow forms are best for vegetables, and the globose types serve as containers. Large, almost tubelike fruits are useful for storage of seeds, flour, and so forth.

Loofah gourds probably vary as much as *Lagenaria* in physiological traits. In Puerto Rico, great differences were seen in the resistance of loofahs to the rainy season, earliness, longevity, and fruit production. In both species, fruits vary in overall shape, from short and compact to long, narrow, or clublike cylinders. Few diseases have been seen in Puerto Rico.

In *L. cylindrica*, varieties differ in bitterness of fruit. Only the sweet are used as vegetables. The sponge gourds also differ in size and thickness of the fibrous mass used as sponge and in the quality characteristics of this fiber.

Cultivars

Cultivars of *Lagenaria* are known throughout West Africa, where the bottle gourd has been grown for containers, but these cultivars are largely unrecorded in terms of name and characteristics. Probably no region has as much diversity and so many named varieties of bottle gourd as India. Amarchandra and Parikh (*1*) tested the yields and

characteristics of 36 named varieties. The principal use in India is as a cooked vegetable, but it is also used as a household medicine. The number of fruits per plant ranged from 3 to 30, and total yield per plant of fruits of the proper maturity ranged from 4 to 55 kilograms. The varieties recommended for Jabalpur are 'White Surat', 'Hot Season Long White', 'Sarmiwali Safaid Lambee 1', 'All Seasons Long', and 'Doodhi Long White'. Two varieties recommended by the Indian Agricultural Research Institute are 'Summer Prolific Long' and 'Summer Prolific Round' (2). Two hybrids produced in India are 'Pusa-Neghdut' and 'Pusa-Manjari' (3). They are earlier and more than 36 percent more prolific than the parent varieties.

Some of the important characteristics in a good variety are evident from the above report. In addition to yield, earliness, and fruit quality, disease resistance is important. The shape of the fruit affects marketability. Long, narrow fruits are the most popular, probably because they are the easiest to use.

Few improved cultivars are available in the case of *L. acutangula*. The great majority of loofahs cultivated are not identifiable varieties. In South India, the recommended variety is 'Pusa Nasdhar', and the small-fruited hermaphroditic variety is 'Satputia' (2).

The sponge gourd is not eaten as frequently, but a selected variety with smooth attractive fruits is 'Pusa Chikni' in India. In Japan, improved varieties are grown for the production of sponges.

CULTIVATION

Climate Requirements and Annual Cycle

Lagenaria is a plant adapted to the dry Tropics. It can be planted in any season of the year, and if soil moisture is sufficient, it will grow rapidly and vigorously and will flower and fruit only 8 weeks after seeding. During the vigorous phase of growth, it will produce several fruits. As these fruits begin to mature, most varieties will cease growth and flowering and will often die. The season of growth is short, sometimes only 3 months. The lifetime of such varieties can be prolonged by removing the young fruits at the proper stage for use as a vegetable. Some varieties that produce extremely large fruits will produce only one fruit per plant if the young fruits are not harvested.

The bottle gourds are not perfectly suited to the hot, humid Tropics, but they can be grown when certain conditions are met. First, proper varieties should be grown, those that are disease resistant and long lived. Next, the gourds should be planted in loamy soil on ridges or mounds to facilitate drainage. Last, the vines should be trained over high trellises where winds can dry the foliage after rains. *Lagenaria* should not be shaded under any condition. In Indonesia, bottle gourds are grown from sea level to 2,000 meters during the

season of the lesser monsoons (short rainy season). In Puerto Rico, bottle gourds have been produced during the wettest season.

In addition, *Lagenaria* can be grown in the Temperate Zone where frost-free conditions last for 3 months or more. The young plants may have to be established first in containers or in hotbeds so that they can be transplanted early to the field. *Lagenaria* can produce abundantly in temperate regions until its growth is ended by frost.

The loofahs, especially *L. acutangula*, are also tropical, and although well adapted to dry regions, some are capable of fruiting during the rainy season of the hot, humid Tropics. No special precautions are needed, and indeed *L. cylindrica* is sometimes found as a spontaneous weed in the Tropics. Nevertheless, loofahs benefit from full sunlight, trellises, and good drainage. Vines grown as ground covers without trellises will flower and fruit, but fruits often rot because of contact with the ground. Loofahs may be grown on fences and thus are one of the best vines for the production of a useful product on a fence row.

Soils, Seeding, and Spacing

Because they grow rapidly, *Lagenaria* and the loofahs require soils of high fertility. In the hot, humid Tropics, heavy clays should be avoided. Sandy soils are suitable, if improved by the addition of manure or compost. In India, this is applied at the rate of 50 to 60 tonnes per hectare. Even so, phosphorus and nitrogen may be applied later to maintain growth.

The bottle gourd and the loofahs are planted year round. Best growth is achieved by seeding at the beginning of the rainy season as days lengthen. The soil should be plowed deeply and formed into ridges or mounds. Optimum spacing for the bottle gourd is 3 meters between plants, and for the loofahs, 1.5 meters.

Postplanting Care

If soil fertility is high, a minimum amount of postplanting care is required, consisting chiefly of weed control and staking. Because of the vigor of their growth, these vines outgrow and shade most weeds. Perhaps only one weeding will be necessary, early in the growth season before the new plants are thoroughly established.

Trellising is an important operation for bottle gourds and loofahs in the hot, humid Tropics. Single poles are not adequate for the vines and fruits these species provide. Heavy wire fencing placed in a permanent row can satisfy adequately the needs of the loofahs. An overhead trellis is recommended for the bottle gourd so that the fruits can hang below the trellis, where they are easily cared for. A Y-shaped trellis of posts and horizontal lines is good, if carefully constructed.

Trellises are often not used during the dry season when bottle

gourds and loofahs can be produced on the ground without serious rotting. Although quality and production are sacrificed, the savings on trellising may compensate.

Loofah fruits produced for sponges are frequently pruned so that fewer but larger fruits are produced. However, it is advantageous to have a maximum number of fruits of *L. acutangula* and bottle gourd.

PESTS AND DISEASES

Lagenaria is likely to be attacked by powdery mildew during the dry season, especially when nights are cool. This mildew is seen principally as a whitish bloom on the surface of the leaves. The leaves turn brown at the tips and margins and die rapidly. Some varieties are so susceptible to powdery mildew that often crops cannot be produced. Others are relatively resistant. Control consists in using resistant varieties.

Mosaic disease, caused by several viruses common to cucurbits, is often a problem in the culture of the bottle gourd. This disease reduces vigor, and infected plants seldom produce large fruits. It is best treated by elimination of diseased plants as quickly as they are noted.

Fusarium wilt of the bottle gourd is controlled by crop rotation. Where wilt has occurred, bottle gourds should not be planted for 2 to 3 years. Fusarium wilt is transmitted in a certain percentage of the seeds. Therefore, seeds should not be saved from wilted plants.

Fruit rots of the bottle gourd are most common when fruits touch the ground, hence the value of high trellises. However, during the rainy season, fruits are much more susceptible to wilts. *Pythium* and *Fusarium* are the main organisms associated with rot. Anthracnose will also cause depressed and rotten spots on the fruit.

The ridged loofah is not susceptible to most diseases. In Puerto Rico, plants have continued to produce through a long rainy season with only minimal disease problems. The young fruits may rot on the vine, a condition often associated with *Mucor*. Adequate aeration is a good protection against fruit rots.

Mosaic disease caused by a virus is sometimes seen with ridged loofah.

The sponge gourd, although not as susceptible to disease as the bottle gourd, is much more likely to be attacked by disease than the ridged loofah. The roots are attacked by nematodes of several species. Foliage may be affected by a mycoplasma that produces witches'-broom. Cucumber mosaic virus affects the vines and reduces fruit set. Rots of the fruit produced by several organisms are common.

Although the typical pests infecting cucurbits in general can attack

bottle gourds and loofahs, few problems have been encountered in Puerto Rico. In other areas, squash bugs, cucumber beetles, the red pumpkin beetle, and *Dacus* fruit flies have been reported.

Chemical controls for insect pests and diseases are not given in this bulletin. Pesticide regulations vary from country to country, and effective controls have often not been checked for residues and other hazards. Therefore, other types of control are mentioned below.

Control of diseases and pests begins with clean culture. Remains of diseased plants should be burned. Fields should be cleaned of plant materials prior to planting. Because all cucurbits tend to have the same diseases, different cucurbits should not be planted together. Crop rotation is an important control measure, especially when part of the previous crop was diseased. Seeds should only be taken from disease-free fruits from disease-free plants. Diseased fruits and plants have less chance of infecting others if destroyed when first observed.

HARVEST AND YIELDS

Since the young fruits of *Lagenaria* and *Luffa* are the parts eaten, the exact stage of harvest cannot be specified here. Although young fruits of all ages are edible, including the ovary of the flower, maximum yield is obtained by harvesting the fruits as late as possible. Bottle gourd fruits can be fairly large, up to two-thirds of mature size, before harvest. Large fruits are not as tender or tasty as small fruits but may be even more nutritive, because the seeds are more highly developed.

Loofah fruits must be eaten at an earlier stage than those of the sponge gourd in order to avoid fibers. The proper stage is about one-third to one-half of the mature size. In any particular variety, the appropriate stage for harvest can best be determined by experience.

Bottle gourd yields are high. Up to 75 tonnes per hectare can be obtained in an exceptional planting. Loofah yields are also exceptional. Sixty thousand fruits per hectare have been collected in Japan for sponges, a yield of at least 50 tonnes of fresh fruit. *L. acutangula* accessions in Puerto Rico have yielded up to 100 tonnes of mature green fruits per hectare.

Bottle gourd and loofah fruits are often marketed, especially in India. The fruits should be packed in small containers such as baskets so that they do not damage each other by their own weight, and they should be removed from sunlight as quickly as possible. The fruits are delicate and easily damaged.

Fruits can be used as vegetables from a few days to 2 weeks after harvest, if kept at ambient temperatures, and they stay fresh somewhat longer under cool temperatures.

UTILIZATION AND NUTRITIONAL VALUE

Uses

Young bottle gourd fruits are eaten as a boiled vegetable. Varieties differ, but the best are slightly sweet, tender, free of bitterness, but sometimes with a slight nutlike flavor, pale green, and attractive. Many varieties are bitter or even insipid and are not attractive to most people. The fruits are often cooked with curries, which mask the natural flavors. The carefully selected varieties of India are choice vegetables, as good and as nutritious as the popular summer squashes of the Temperate Zone.

The top of the gourd is cut away and the seeds and pulp are scooped out. If the opening is large, it may be possible to scrape the inside carefully. Sometimes the partially cleaned gourd is allowed to stand, and rot further softens the tissue. An excellent technique is to fill the partially cleaned gourds with clean, dry sand, and to cover them in a larger container with sand. This is heated over a fire for several days, and the gourds are carefully dried out. Patterns may be cut into the gourds before they are dried, or the shells may be forced into desired shapes. Dried gourds are cleaned again. The interior is scraped to remove dried pulp, and may be waxed. The exterior may be painted or shellacked. Well-treated gourds become durable containers. The dry hard shells are used for bottles, milk pots, churns, bowls, ladles, spoons, work baskets, floats, pipes, carved objects, and musical instruments.

Lagenaria seeds are sometimes used in melon-seed soups in West Africa. They represent the most nutritious part of the fruit and as such need study and development.

The fruits of the sweet variety of *L. cylindrica* may be eaten raw in salads just as the cucumber fruits. Slices may be dried for later uses. Small fruits are pickled as well. Most young fruits are boiled, however, and may be combined in dishes with meats or with curries. Older loofah fruits are purgative and can be used medicinally.

When bottle gourds are to be used as containers, they may be constricted by bands to particular shapes. The gourds are permitted to obtain a maximum maturity on the vine before harvest. When harvested with a short length of vine, they can be hung from wires below a hot ceiling, where they dry out. However, the drying process is slow, and other measures are often used.

Techniques for the preparation of sponges from *L. cylindrica* are given by Porterfield (*13*). Although dry ripe fruits may be used for this purpose, the best sponges are made from the mature but still green fruits. These fruits are wetted in water for several days, after which the outer skin is easily removed. Further wetting may be necessary

until all of the pulp and seeds are removed. The clean sponges may be bleached with hydrogen peroxide before hanging them on a line to dry in the sun. Other techniques are also used.

The sponges of *L. cylindrica* have a variety of uses. The most important use has been as a filter in marine steam engines. They are popular for the bath, especially in Europe. The fibers are tough and are used in many durable products such as doormats and sandals. Loofah sponges are easy to grow and eliminate the need for artificial plastic sponges, dish cleaners, and so forth now so popular in the market.

Oils from bottle gourd seeds have been used to some extent in Nigeria (*12*). Angled loofah seed oils tend to be bitter and *may be poisonous* (see later). The oils of the smooth *Luffa* are not bitter.

A vegetable curd similar to soybean tofu can be made from the seeds of *Lagenaria* and *Luffa*. The curd from *Lagenaria* seeds is an attractive tan color and of mild flavor. The curd from *L. cylindrica* seeds is grayish, unless white-seeded varieties are used. The seed must be free of bitterness. The curd from seeds of *L. acutangula* is unacceptably bitter. Further study is needed of the edibility of these new food products.

Composition

The compositions of bottle gourds and loofahs are summarized in table 1. Neither the bottle gourd nor the loofahs are an important source of any nutrient. The vitamin C content might be of marginal value but only when edible leaves are not available.

Tests of angled loofah seeds for oil and protein content show a variation in oil content from 18.3 to 24.3 percent and in protein from

TABLE 1.—*Composition of young bottle gourd and loofah fruits*

[Per 100 grams edible portion]

Component	Bottle gourd[1]	Rigid loofah[1]	Sponge gourd[2]
Water ..... %	96.1	95.2	94.7
Calories ..... cal	12	12	23
Protein ..... g	0.2	0.5	0.5
Fat ..... g	0.1	0.1	0.2
Fiber ..... g	0.6	0.5	0.5
Vitamin A ..... IU	0.0	56	45
Vitamin B ..... mg	0.03	0.07	0.04
Vitamin B_2 ..... mg	0.01	0.01	0.02
Vitamin B_3 ..... mg	0.2	0.2	0.03
Vitamin C ..... mg	6	5	11
Calcium ..... mg	20	40	16
Iron ..... mg	0.7	1.6	0.6

[1]According to Choudhury (*2*).

[2]Estimated from Porterfield (*13*) and Intengan et al. (*7*).

18.0 to 25.0 percent among 40 accessions tested. Variation in oil ranged from 20.5 to 25.6 and in protein from 16.4 to 26.4 among 34 varieties of *L. cylindrica* (unpublished data of author).

TOXIC QUALITIES

In addition to nutrients, fruits and seeds of bottle gourds and loofahs contain *poisonous* substances. The older and more bitter fruits contain purging substances, which is probably the main medicinal effect, although the fruits are widely used for folk medicine. According to Porterfield (*13*), who has summarized the available information on loofahs, two glucosides are found in the fruit, one a severe emetic, the other a cathartic that irritates and leads to dysenteric symptoms. In addition, fruits contain saponins. The seeds of some loofahs are *poisonous*, and they contain strongly bitter substances. Two saponins yielding sapogenins on hydrolysis have been partially characterized by Varshney and Beg (*17*). The evidence for and against the poisonous qualities of *Luffa* seeds has been summarized by Watt and Breyer-Brandwijk (*18*). Apparently, bitterness and poisonous substances occur in some varieties but not in others of both species. When not bitter, seeds are edible.

Because the seeds from other cucurbits are often eaten and contribute protein as well as oil to the diet (5), the edible qualities of the seeds of bottle gourds and loofahs merit investigation. The known differences in bitterness of the fruits suggest that useful variation might be found as seeds free of toxic properties.

PROSPECTS FOR THE FUTURE

Neither the bottle gourds nor the loofahs promise to be of great value as vegetables in the Tropics. Yet each species has played an important role before and is likely to have its special uses in the future. Bottle gourds, for example, yield one of the few containers that can be produced in the garden. They are made from a renewable resource, and their use does not interfere with ecological relations or destroy a fossil fuel. The sponge gourd yields another renewable resource that is likely to be useful for ages to come. Each species is unique in its own way and valuable.

The bottle gourds and the loofahs are not excellent foods. When harvested at the appropriate time, they are a delicious supplement to the diet but of little food value. Nevertheless, eating is more than acquiring nutrients, and it is obvious that the fruits of these species are appreciated. Westerners who try them like them. Furthermore, these species have the advantage that they can be produced year round. *Lagenaria* can be produced during the dry season and the

beginning of the rainy season, *L. acutangula* throughout the year, and *L. cylindrica* throughout the year except perhaps for the wettest months of the rainy season. Because they can be grown on fences, they are one of the crops that can convert this portion of a small lot to food production.

Another possible use of these species, still almost unexplored, is the use of the seeds for their protein and oil contents. Varieties with edible seeds, free of toxic substances, might be found. *Lagenaria* and *Luffa* could become important, easy-to-grow sources of protein and oil for the hot, humid Tropics.

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